

laser physics

By
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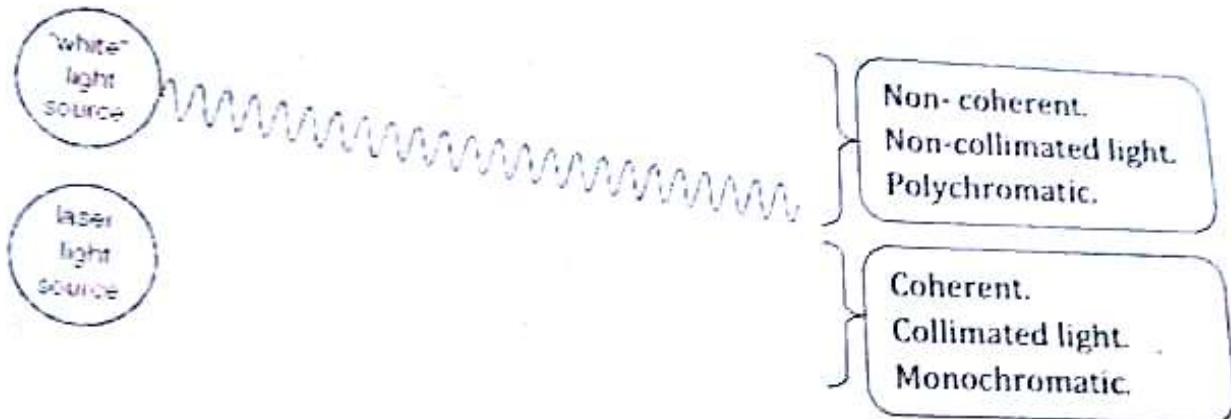
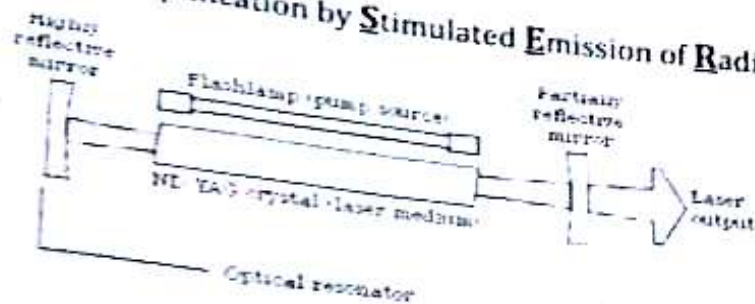
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Basic of laser system

❖ Definition:

Light Amplification by Stimulated Emission of Radiation.



❖ Laser types:

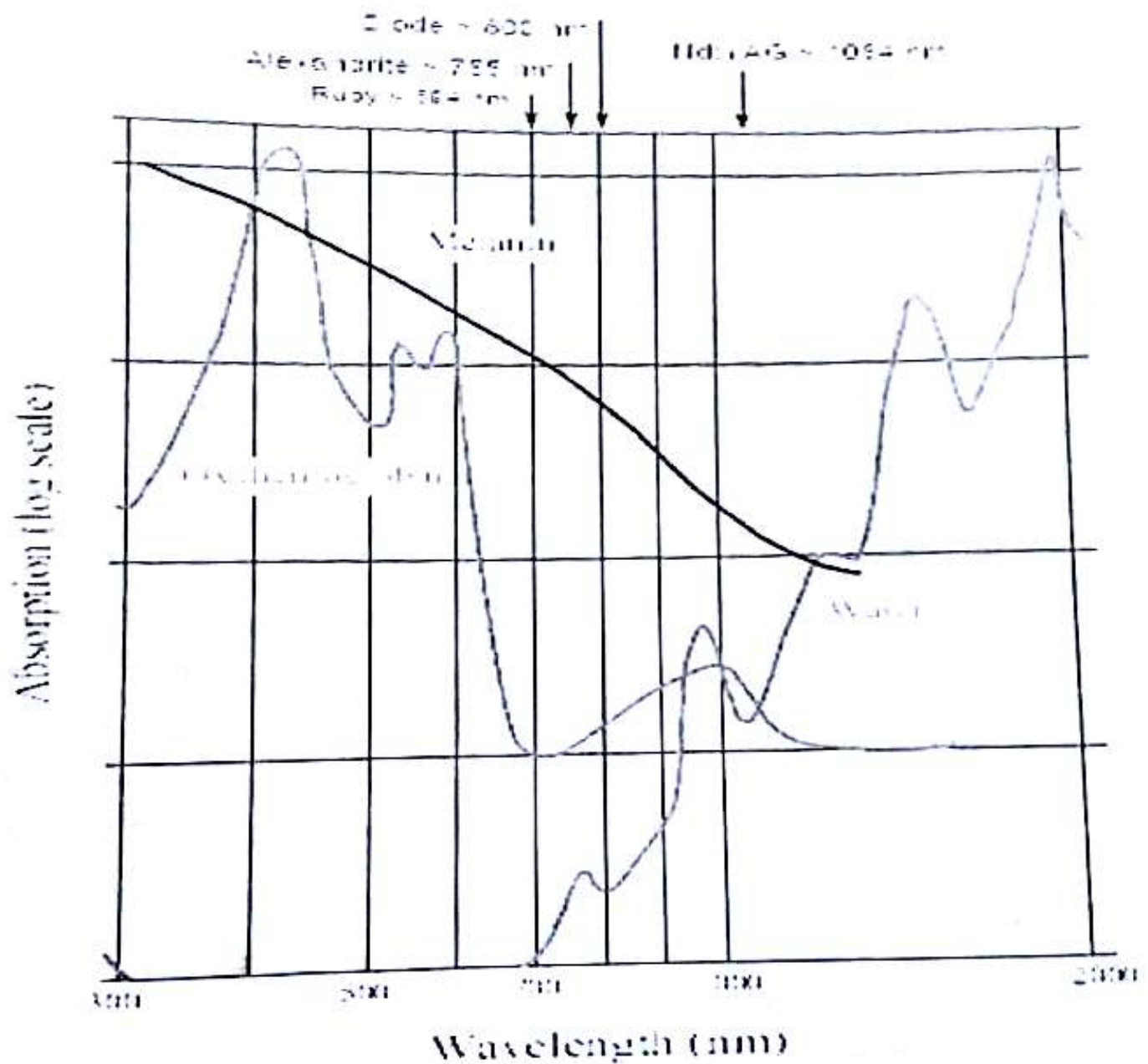
- Semiconductor laser (Diode).
- Solid state laser (Alexandrite, NdYAG).
- Liquid state laser (Dye laser).
- Gas state laser (CO₂).

❖ Laser terms:

- Power is measured in → Watts.
- Power density is measured by → Watts/Volume.
- Energy is measured in → Joules.
- Energy fluence is measured by → Joules/Area.

❖ **Skin chromophores & their relations to different layers of skin;**

- **Melanin:** normally found in melanocytes & in the nearby epidermal cells + hair shaft.
- **Haemoglobin & oxyhaemoglobin:** present in the dermal vascular network.
- **Water:** constitutes a major component of every cell (epidermal or dermal).
- **Protein:** form an important part of every living tissue (epidermal or dermal).

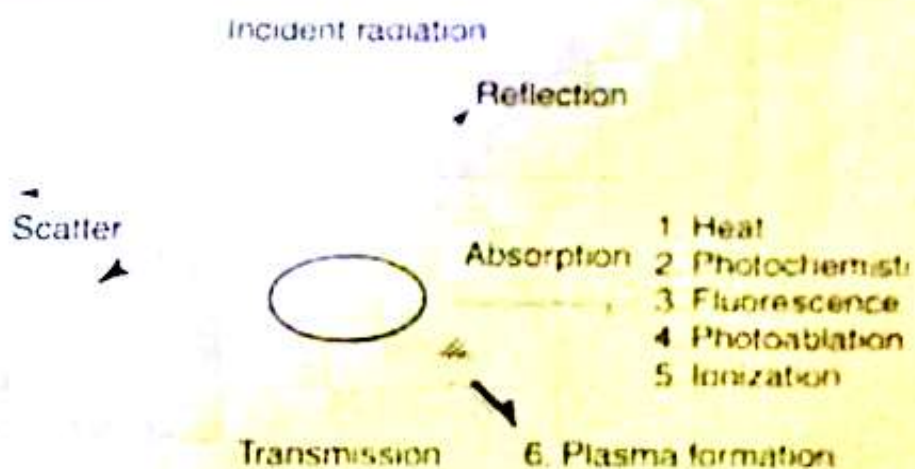


❖ Laser wavelengths & associated chromophores:

Wavelength (nm)	Laser	Skin chromophores
170-400	Excimer	Protein
488	Argon	Melanin
514	Argon or Dye	Melanin, Blood
532	Doubled Nd: YAG	Melanin, Blood
578	Copper Vapor	Blood
585-600	Pulsed Dye	Blood
694	Ruby	Melanin
755	Alexandrite	Melanin, Blood
810	Diode	Melanin
1064	Nd: YAG	Melanin
2940	Erbium YAG	Water
10,600	CO ₂	Water

❖ Laser-tissue interaction:

- Reflection.
- Scattering.
- Transmission.
- Absorption by chromophores.



❖ Thermal relaxation time:

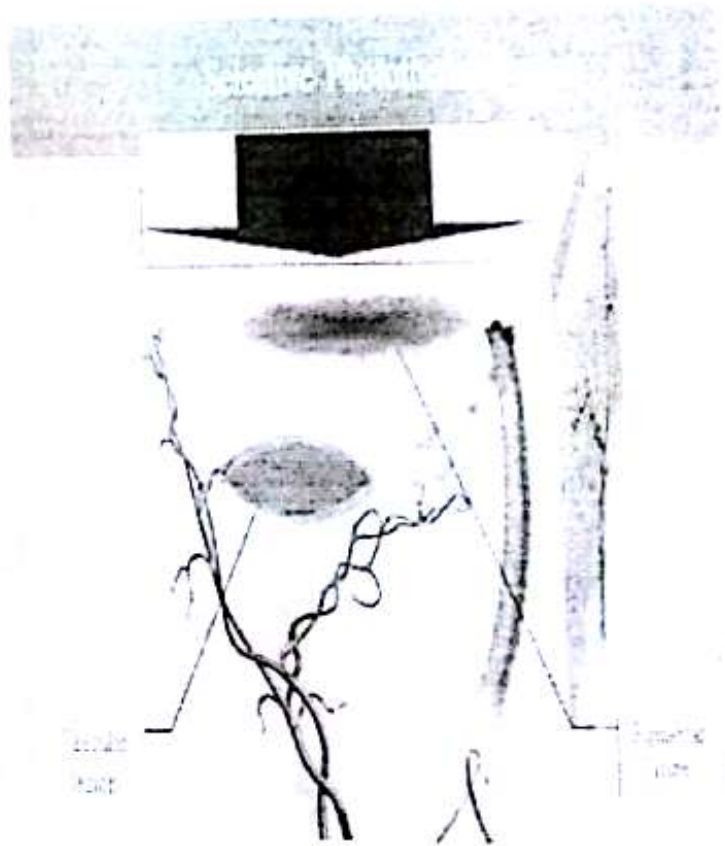
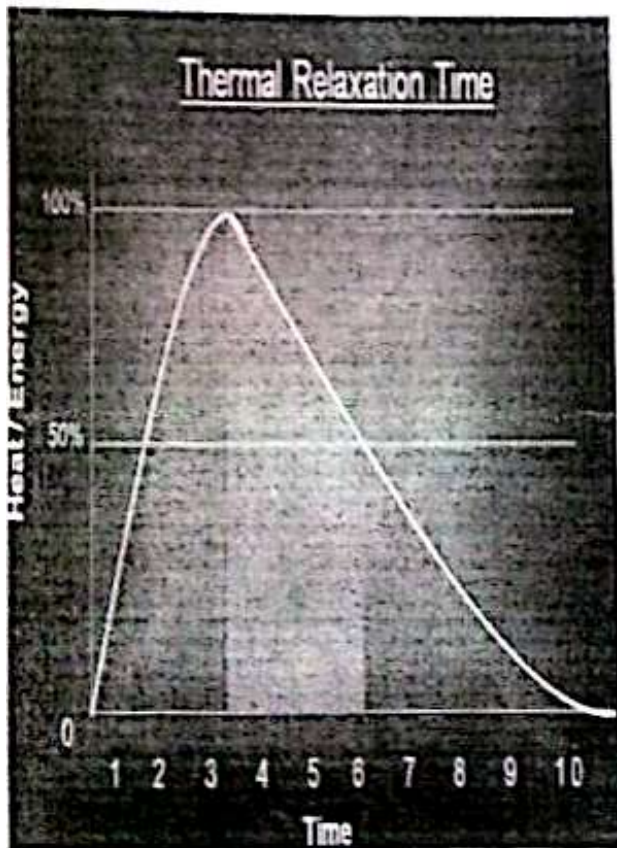
- The time necessary for the target to cool down 50%, through the transfer of its heat to surrounding tissue via thermal diffusion.
- The thermal relaxation time is directly related to the size of the target & its composition. (e.g. smaller objects of the same material will lose heat at a much faster rate than larger objects).

❖ Selective photothermolysis:

- With the selection of a preferentially absorbed laser wavelength and its delivery at the appropriate pulse duration and fluence, specific target structures can be destroyed while limiting damage to the surrounding.

❖ Optimum end results:

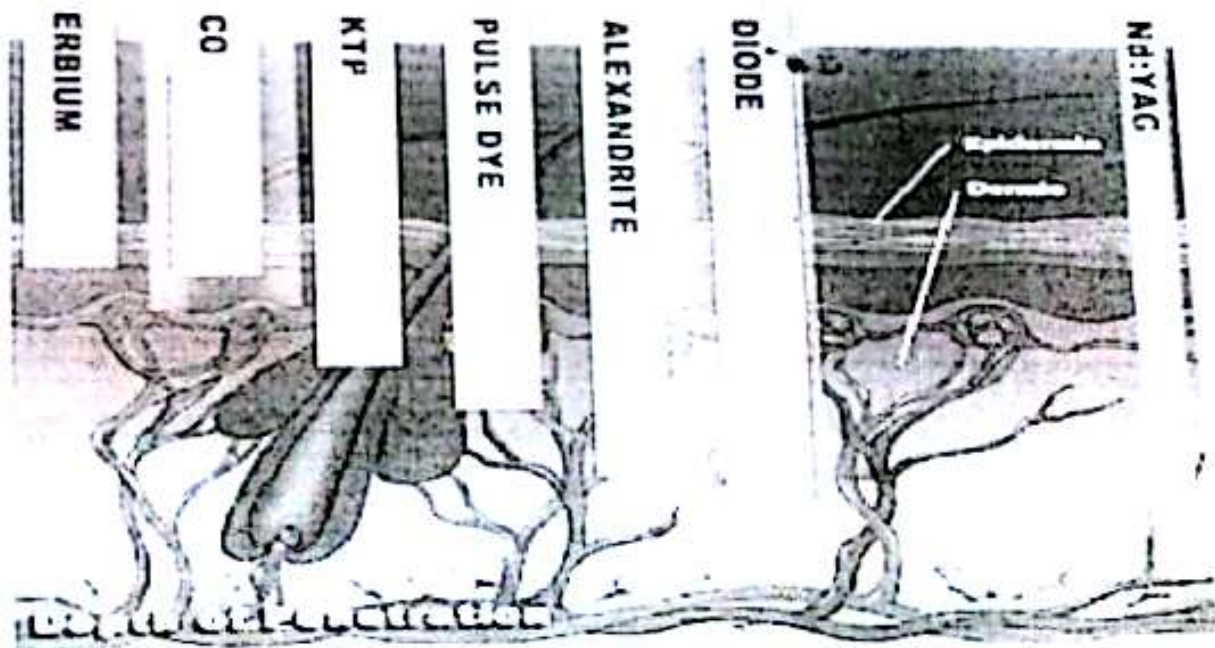
- Target destroyed.
- Surrounding tissue spared.
- Normal skin tone/texture.



❖ Target destruction:

- For target destruction, the output of the laser must match the following characteristics of the target:
 - Light absorption: **wavelength**.
 - Temperature rise: **absorbed energy**.
 - Time for destruction: **pulse duration**.
- **N.B: TRT (target structure's):**
 - Size: The TRT of a target is proportional to the square of its size.
 - Shape: spheres cool faster than cylinders, which cool faster than planes.

Chromophore	Diameter	TRT	Typical laser pulse duration
Tattoo ink particle	0.1 μ m	10ns	10ns
Melanosome	0.5 μ m	250ns	10-100ns
PWS vessels	30-100 μ m	1-10ms	0.4-20ms
Terminal hair follicle	300 μ m	100ms	3-100ms
Leg veins	1mm	1s	0.1s



❖ Laser-tissue interaction outcome:

- Heat/Cook: hair removal, vascular, thermotherapy.
- Cut/Ablate: resurfacing.
- Photo-Acoustic Effects: tattoo.
- Catalyst: photodynamic therapy.

❖ Parameters affecting laser-tissue interaction:

- **Wavelength** – Absorption.
- **Fluence or Power Density** – Energy Input.
- **Pulse Duration** – Energy Flux.
- **Spot Size** – Penetration Depth.

N.B: optical penetration into skin governed by a combination of absorption and scattering. Spot size plays a significant role.

❖ Skin cooling:

- **Aim:**
 - To minimize epidermal damage and protect melanosomes.
 - Especially in dark skin types.
- **Methods:**
 - Gas:
 - Air cooling.
 - Liquid:
 - Spray cooling (temperature lower than skin surface, cooling occurs via evaporation of the coolant layer from liquid to gas).
 - Solid:
 - Solid contact: with high thermal capacity and conductivity, it is kept at a constant temperature via active cooling mechanisms.
 - Cold gel: passive cooling.

❖ Laser safety:

Eye injury: goggles.

Fire: CO₂, Erbium...

Inhalation of fumes: smoke evacuator.

Laser used in dermatology

- **Ablative:**
 - Erbium: YAG (2940 nm) water.
 - Carbon dioxide (10600nm) water.
- **Excimer (308nm):**
 - Vitiligo.
 - Psoriasis.
- **Non-ablative lasers:**
 - 1320nm Nd: YAG.
 - 1450nm diode.
 - 1540nm erbium: glass lasers.
 - 585-nm and 595-nm PDL.
 - Pulsed light sources.
- **Vascular:**
 - Pulsed dye (585-600nm).
 - Nd: YAG (1064nm).
 - Diode (800nm).
 - Argon (488,514nm).
 - Frequency-doubled Nd: YAG/KTP (532nm).
- **Melanin (hair [LP], tattoo, melanosomes[Q]):**
 - Ruby (694nm).
 - Alexandrite (755nm).
 - Diode (800nm).
 - Nd: YAG (1064nm).
 - Frequency-doubled Nd: YAG/KTP (532 nm).

N.B:

- Long pulsed (LP) = pulse duration in milliseconds.
- Q-switched = pulse duration in nanoseconds.
- ('Q' refers to a quality factor of energy storage in the lasing medium, which is changed suddenly to produce a short, intense burst of light).

➤ Non-ablative lasers

- Works by subtle thermal effects on the dermis, but they leave the epidermis intact.
- The mechanisms are unknown, but presumably involve stimulating a wound healing response in the dermis.
- Non-ablative therapy may also help fade irregular pigmentation of the skin.
- Unlike a facelift or conventional laser resurfacing, the results from non-ablative rejuvenation are gradual and subtle.
- Well-controlled studies are lacking. The present commercial marketing for non-ablative rejuvenation probably overstates its value.

➤ Ablative lasers


CO2

Erbium

Indications of ablative lasers:

- Rejuvenation.
- Acne scars treatment.
- Epidermal nevus.
- Seborrheic keratoses and DPN.
- Verruca vulgaris.
- Xanthelasma.
- Sebaceous gland hyperplasia.
- Syringoma.
- Trichoepithelioma.
- Scar revision.
- Hailey-Hailey disease.
- Darrier disease.

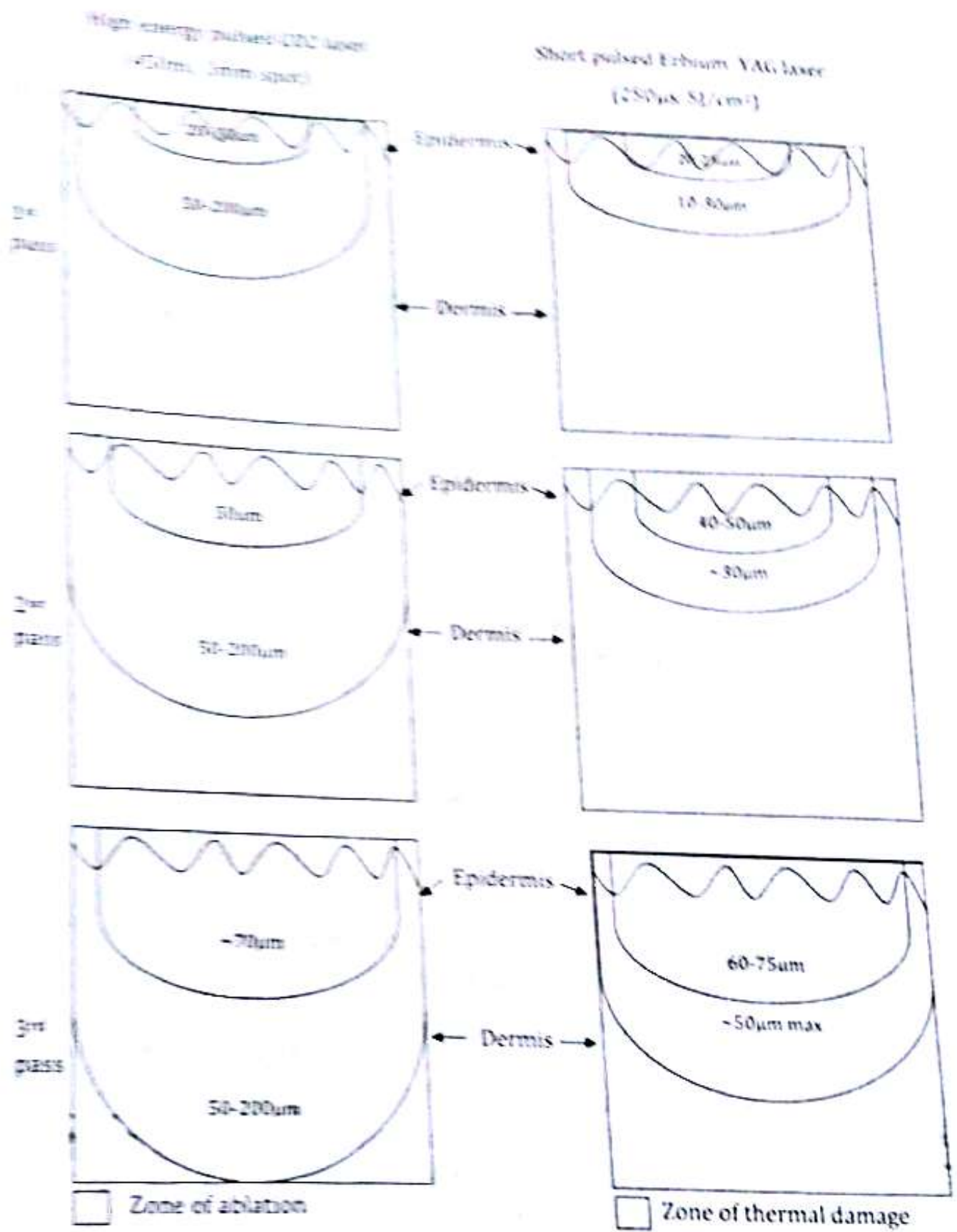
❖ CO2 Laser

- 10,600 nm wavelength.
 - Strongly absorbed by tissue water (absorption coefficient of 800cm^{-1}).
 - The penetration depth is dependent upon a tissue's water content.
 - With pulse duration of less than 1ms, CO2 laser light penetrates approximately 20-30 μm into the skin, and residual thermal damage can be confined to a 100-150 μm layer of tissue, although thermal coagulation up to 1mm has been reported.
 - Epidermal ablation occurs after 1 pass of the CO2 laser at standard treatment parameters (vaporizing tissue to a depth of 20-60 μm), but collagen shrinkage and remodeling (the 2 factors most likely responsible for the long term clinical improvement seen after resurfacing): requires an additional 1 to 2 passes.
 - Two basic CO2 laser system have been utilized in cutaneous resurfacing:
 - High-powered pulsed CO2 laser system.
 - Scanned CO2 CW laser.
- 
- Ultrashort pulse durations (shorter than the TRT of water-containing tissue).
 - Higher energy densities.
 - Controlled tissue ablation with limited coagulative necrosis of unintended neighboring structures.
 - Gold standard for facial rejuvenation, the system by which all others are compared.
 - The fluence required to achieve pulsed-laser ablation of skin tissue is 5 J/cm^2 , with less energy producing diffuse tissue heating without vaporization.
 - Small beams (100-300 μm in diameter):
 - Achieving high fluences and rapid tissue vaporization; however, the beam must be moved rapidly across the skin surface to avert desiccation, charring and heat diffusion.
 - Beam diameters of greater than 2 mm:

- Induce non-vaporization heating and increase the risk of deep thermal damage due to the need to apply low fluences for longer periods of time in order for visible vaporization to occur.

❖ Erbium YAG laser

- 2940nm wavelength.
- 16 times more absorption by water.
- Absorption peak of water is 3000nm.
- One joule/cm of erbium = 4U (2-5) of ablation and (10-15 microns) of thermal damage.
- At a fluence of 5 J/cm² → vaporizes the epidermis in four passes, while 8-12 J/cm² achieves this after two passes.
- Shallower ablation (epidermis and papillary dermis).
- With multiple passes of the Er: YAG laser → the depth of the underlying thermal damage is limited to 50µm.
- Less tissue tightening or contraction as compared to the CO₂ laser.
- Lower efficacy due to less thermal effect.
- Less down time.
- Pulse duration of Erbium:
 - More thermal effect (less ablation) with higher pulse duration:
 - Short pulsed (250-350µs, ablation).
 - Long pulsed (500 microseconds-10 milliseconds, coagulation).
 - Dual pulsed.
 - Variable pulsed laser (pulse durations of 10-50ms).
- Short pulsed Er: YAG laser → bleeding & less heating (less tissue tightening).



Water absorption by CO₂ vs. Erbium:

Water absorption: (N.B. 90% of the epidermis composed of water)	CO ₂ laser	Erbium laser
	<ul style="list-style-type: none">Water absorption coefficient of (800 cm⁻¹).	<ul style="list-style-type: none">Water absorption coefficient of (12,800 cm⁻¹).More efficiently absorbed by water by a factor of 12-18.

Side effects & complication of ablative lasers:

- **Erythema:**
 - CO₂ → 2 months.
 - Erbium → 1 month.
- **Dyspigmentation.**
- **PM:**
 - In up to 36% of patients.
 - More common during the summer months & year-round in sunny areas.
 - Usually resolves within a few months.
 - Pretreatment with bleaching creams and retinoic acid reduces risk.
- **Two types of hypopigmentation:**
 - **Relative hypopigmentation of the resurfaced skin:**
 - As compared to the background untreated skin.
 - Minimized by resurfacing the entire face or at least entire cosmetic units.
 - Feathering.
 - A medium-depth chemical peeling of the untreated areas.
 - **Delayed hypopigmentation:**
 - Develops 6-12 months after resurfacing 16%.
 - An unexplained delayed loss of pigmentation.
- **Acneiform eruption:**
 - ~~May~~ result from follicular reepithelialization compounded by the use of occlusive moisturizers.
 - ~~Are~~ common in patients with past history.
 - ~~Usually~~ develops in the first few weeks.

- **Eczematous dermatitis:**
 - Topical anesthetics: increases the chances of postoperative erythema and hyperpigmentation.

MTZ:

- Microscopic treatment zones (MTZ) of controlled width, depth & densities are created.
- Controlled zones of thermal heating and tissue damage are surrounded by spread areas of viable epidermis and dermis that allow for rapid repair of the MTZ.

MENDs:

- Within 1 hour after laser irradiation, well-defined columns of both epidermal and dermal thermal damages are seen with an intact overlying stratum corneum.
- Within 24hrs, there is migration of viable cells from the periphery of the MTZs along with formation of microscopic epidermal necrotic debris (MENDs).
- MENDs comprise epidermal and dermal thermally damaged cells along with melanin and elastin.
- The MENDs undergo transepidermal extrusion between 3 and 7 days.
- Cellular markers of dermal wound healing and neocollagenesis such as heat shock protein 70, collagen III, PCNA, and alpha-SMA were expressed within the treatment areas.

Ablative fractional lasers:

- Cause true ablation of the epidermis in addition to variable depths of ablative damage to the dermis.
- More robust wound healing response.
- Rapid and significant clinical effects.
- Rapid healing and minimal side effects compared to ablative laser.

➤ Vascular lasers

- ➔ Pulsed Dye (585-600 nm)
- ➔ Nd: YAG (1064 nm)
- ➔ Diode (800 nm)
- ➔ Alexandrite (755 nm)
- ➔ Argon (488, 514 nm)
- ➔ Frequency-Doubled Nd: YAG/KTP (532 nm) {LP}
- ➔ IPL

Vascular uses:

- PWS.
- Hemangiomas.
- Angiokeratoma of Fordyce.
- Cherry angioma.
- Spider angioma.
- Venous lake.
- Pyogenic granuloma.

Non-vascular uses:

- Warts.
- Molluscum contagiosum.
- Psoriasis.
- Stria rubra.
- Scars.
- DLE.
- Non-ablative dermal remodeling.

Choice of vascular laser:

- Location depth.
- Vessel caliber.

Short wave vs. long wave vascular lasers:

- The 3 selective peaks in the green and yellow range are targeted by the PDL lasers, and somewhat by intense pulsed light (IPL).
- Longer wavelength (700-to-1100 nm range):
 - Better penetrates the dermis.
 - Uniformly heat the full circumference of the vessel.
 - Results in vein closure.
- Shorter wavelength:
 - Heat only the anterior vessel wall.
 - Results in incomplete thrombosis.
- Wavelengths greater than 900 nm are less specific and also target water, so higher fluencies are required, which can cause unwanted damage to surrounding tissue (cooling!).

Different blood vessels have different TRTs:

- Capillaries have a TRT of tens of microseconds.
- PWS venules have a TRT of tens of milliseconds.
- Leg veins have a TRT of hundreds of milliseconds.

❖ PDLs

- **Original PDL (577 nm, PD: 0.3 ms):**
 - Coinciding with the last absorption peak of oxyhemoglobin.
 - To shallow penetration.
- **PDL (585 nm, PD: 0.45 ms):**
 - Allow for deeper tissue penetration.
 - Less selective vascular injury.

Side effects of PDL:

- Purpura: lasts 7-14 days.
- Hyper- and hypopigmentation.
- Atrophic and hypertrophic scarring.
- The risk of complications is greater in patients with darker skin types.

❖ Nd: YAG (1,064 nm, Infrared)

- Can penetrate to a depth of 4 to 6 mm.
- Treatment of deeper vessels.
- Deeper penetration results in more pain.
- Lower absorption coefficient for melanin: safe for darker skin types.
- Increased the risk of blistering and scarring.

❖ Diode lasers

- Diode (800, 810, 940, 980 nm, Near Infrared).
- Target the tertiary hemoglobin peak: very limited but significant hemoglobin absorption.
- Penetrate more deeply than the yellow and green light lasers.
- Poorly absorbed by melanin.
- For facial and leg telangiectasia.

❖ Intense pulsed light

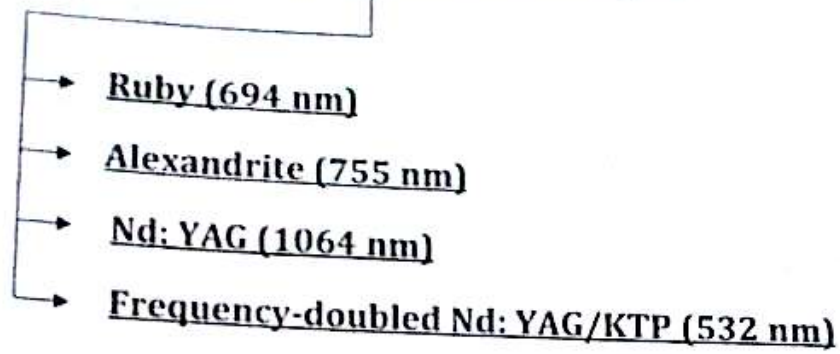
- 515-1,200 nm, Yellow, Red and Infrared.
- Developed in 1993.
- Emits polychromatic non-coherent broadband light from 515 to 1,200 nm in single, double or triple pulses 2 to 25ms in duration.
- Rectangular spot size of 3.5×0.8cm.

- A coupling gel is applied to the skin before treatment to minimize epidermal damage and increased the efficiency of light delivery to deeper structures.

❖ Alexandrite laser (755 nm)

- Positioned between the 532-to-595 nm and 1064 nm lasers.
- Compared to 1064 nm
 - Twice the photon absorption by hemoglobin.
 - More effective vessel heating per J/cm²
- Compared with 532-to-595 nm lasers:
 - Less hemoglobin absorption.
- Much deeper photon penetration and scattering.

➤ Q-switched lasers for
Tattoos & pigmentation



- Melanin is located within melanosomes, organelles that range from 0.5 to 1.0 μ m in size.
- Based on the theoretical TRT of melanosomes, the optimal pulse duration is 70-250ns.
- When the fluence threshold for melanosome disruption is reached, the pigmented cell dies.
- Treatment of tattoos with short-pulsed lasers leads to fragmentation of the ink particles and selective death of pigment-containing cells, with resultant pigment release. There are several speculated mechanisms for removal of the pigment particles.
- Some ink is:
 - Lost in an epidermal crust.
 - Some is lost via the lymphatics.
 - And some is rephagocytosed by dermal cells.

Q-switched lasers:

- The Q-switched Nd: YAG laser:
 - Pulse duration of 10 ns.
- Q-switched alexandrite laser:
 - 50-100 ns pulse duration.
- 694 nm deep red light:
 - At fluences of up to approximately 10J/cm².
 - 20-40 ns pulse duration.
- The 1064 nm energy can be frequency doubled to produce 532 nm visible green light by passing it through a KTP crystal.
This frequency-doubled Nd: YAG laser can effectively remove epidermal melanin pigment as well as red and yellow tattoo ink, but not green ink.
- Pigmented lesions can be classified either:
 - Based on location of pigment:
 - Epidermal.
 - Dermal.
 - Based on causation:
 - Nevoid / hereditary.
 - Acquired-drug induced, post-inflammatory, hormonal.

➤ Laser hair epilation

- Ruby (694 nm)
- Alexandrite (755 nm)
- Diode (800 nm)
- Nd: YAG laser (1064 nm)
- Frequency-doubled Nd: YAG/KTP (532 nm)

Laser hair removal principles:

- Permanent hair **reduction** & not permanent hair removal.
- Target: damage hair without damaging surrounding tissue.
- Only hair in anagen stage reacts to laser.
- Black or brown hair responds to laser.
- White or blonde hair **not** responds to laser.

Challenge of laser hair removal:

- Melanin is present in both epidermis and hair shaft.
- Epidermal safety is determined by amount of melanin present and laser parameters (wavelength, fluence & cooling).

Alexandrite laser 755 nm:

- Skin types I-III (moderate melanin contents in epidermis).
- Fine & coarse hair responds.
- Suggested parameters:
 - Pulse duration required → 5-20 ms (short pulse duration/higher peak power for fine hair).
 - Fluences chosen to cause destruction.

Nd-YAG 1064 nm:

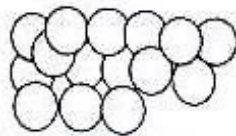
- Suitable for all skin types.
- Skin types IV-VI with high melanin content in epidermis can be treated.
- Longer pulse duration required to destroy target while preserving epidermis.
- More energy absorbed by tissue, less fluence reaches target → higher fluences required to destroy target.
- Thick hair **NOT** thin.
- Suggested parameters:
 - Pulse duration 20-60ms.
 - Fluence 35-50 Jcm².

Treatment expectations:

- Decreased hair density by 70-80%.
- Decreased hair thickness.
- Decreased hair growth rate.

Treatment procedure:

- Pulses are delivered in a linear fashion with a 10% overlap between pulses.



- A decreased in fluence may be necessary in sensitive areas such as the upper lip, shin, ankle and bikini areas.

Post-treatment care and instructions:

- Apply ice immediately.
- Apply a soothing cream for the first few days after procedure especially if scabbing occurs.
- Do not pick at scabs → this could cause scarring.
- If hypo-or hyperpigmentation occur → they will usually resolve within 4-6 weeks.

Adverse effects:

- Blistering during treatment may be an indication of sun exposure or too high a fluence for the skin type.
- Pustules may develop in the first few days following treatment.
- Hyperpigmentation or hypopigmentation due to high doses or improper patient selection → fades.
- Scarring → very rare.

Contraindications for laser:

- Sun exposure in the last 4 weeks especially if tanned, use of self tanning cream.
- History of light sensitive seizures.
- Suspicious pigmented lesions.
- Intake of medications known to increase light sensitivity: isotretinoin, gold treatments, tetracyclins.
- Anticoagulant therapy.
- Light sensitivity to infrared rays.
- Pregnancy.

Botox

By
Dr. Maged El Shiekh (MD)

Botulinum toxin A

Medical Indications:

- Hyperhidrosis.
- Dystonia.
- Dysphonia.
- Strabismus.
- Spasticity.
- Cerebral palsy.
- Nystagmus.
- Multiple sclerosis.

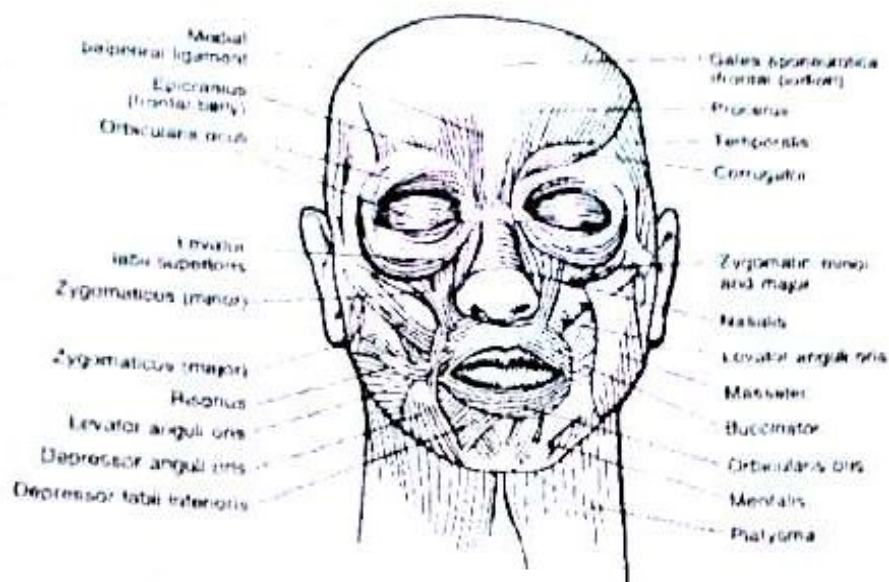
Introduction:

- Botulinum neurotoxins (BTXs) are derived from the bacteria *Clostridium Botulinum* and include seven serotypes.
- Botulinum toxin type A (BTX-A) was first introduced in the early 1990s for cosmetic indications, however, it has been used earlier for other indications e.g. cerebral palsy.
- All BTX subtypes block neuromuscular transmission by binding to receptor sites on motor nerve terminals and inhibiting the release of acetylcholine.
- When injected intramuscularly at therapeutic doses → BTXs produce temporary chemodenervation of the muscle.

Wrinkles:

- Generally, wrinkles are either:
(Dynamic or static)

Dynamic wrinkles	Static wrinkles
Result from powerful underlying muscle contraction.	Result from photoaging or long standing dynamic wrinkles.



Basic surgical anatomy:

Muscle	Function
<ul style="list-style-type: none"> • Frontalis: • Corrugators: • Procerus: • Depressor supercilii: • Orbicularis oculi: • Risorius: • Orbicularis oris: • Levator labii superioris: • Depressor anguli oris: • Depressor labii inferioris: • Levator anguli superioris: • Nasalis: • Mentalis: • Platysma: 	<ul style="list-style-type: none"> • Raises the eyebrows & produces transverse wrinkles of the forehead. • Brings the eyebrows towards each other. • Pulls the glabellar skin in an inferior direction & causes a transverse rhytid. • Depresses the eyebrow. • Functions as the sphincter of the eye. • Draws the corners of the mouth laterally. • Sphincter of the mouth. • Raises the upper lip. • Depresses the corner of the mouth. • Lowers the lower lip. • Raises the corners of the mouth. • Alar flaring and compression. • Lowers the lower lip. • Non specific.

Botox in hyperhidrosis

Physiology of sweating:

- Central nervous system sweat pathway:
 - Cerebral cortex → hypothalamus → brain stem → spinal cord → sympathetic ganglia → sweat glands.

Causes of sweating:

- **Primary:**
 - Genetic (65% have family history).
 - Sympathetic nervous system hyperactivity.
 - Sympathetic nervous system dysregulation.
 - Hypothalamic dysfunction.
- **Secondary:**
 - Spinal cord injury.
 - Peripheral nervous system pathology.
 - Diabetes.
 - Malignancies.
 - Rarely associated with psychopathology (mostly a reaction to the disease).

Clinical diagnosis of 1st hyperhidrosis:

- Excessive sweating, beyond physiological needs.
- Focal, visible, excessive sweating of at least 6 months duration without apparent cause with at least 2 of the following characteristics:
 - Bilateral and relatively sympathetic.
 - Impairment in daily activities.
 - Frequency of at least 1 episode per week.
 - Age of onset less than 25 years.
 - Positive family history.
 - Cessation of focal sweating during sleep.

N.B: diagnosis should be made only after excluding 2nd causes of excessive sweating.

Treatment algorithm for 1st local axillary hyperhidrosis:

Evidence-based guidelines:

1) Topical over-the-counter antiperspirants.



2) Aluminum chloride 10%-35% topical antiperspirant (L6).



3) Intradermal injections of Botulinum toxin type A.



4) Surgery: local sweat gland resection or endoscopic thoracic sympathectomy (L7).

Hyperhidrosis disease severity scale (HDSS):

A 4 points scale for categorizing severity of 1st axillary hyperhidrosis:

My underarm sweating is:

1) Never noticeable and never interferes with my daily activities.

2) Tolerable but sometimes interferes with my daily activities.

3) Barely tolerable and frequently interferes with my daily activities.

4) Intolerable and always interferes with my daily activities.

- HDSS scores of 3 or 4 may be used as indicators of severe disease.

Mechanism of action:

- Botulinum toxin A is a natural, purified protein with the ability to temporarily block the neuromuscular transmission by binding to receptors on motor or sympathetic nerve terminals → inhibition of acetylcholine as the neurotoxin cleaves SNAP-25 which is responsible for the release of acetylcholine from vesicles within the nerve endings.
- If it is injected intramuscular → partial chemical denervation of the muscle → localized reduction of muscle activity.

- If it is injected intradermally → temporary chemical denervation of the sweat gland → local reduction of sweating.
- It doesn't cure hyperhidrosis, the symptoms will return gradually & follow up injection are needed to maintain dryness at intervals from 7-16 months.

Doctors must ask about:

- Plans to have surgery or previous surgery.
- Weakness of forehead muscles (difficulty in raising eyebrow, droopy eyelid).
- Pregnant or plans to get pregnant.
- Breast feeding.
- Muscle or nerve condition e.g. myasthenia gravis.
- Any received Botulinum toxin in the last 4 months, antibiotic by injection, muscle relaxant.

Dosage & administration:

- Don't exceed a total of 360 units injected in a 3 months interval.
- In axillary hyperhidrosis: 50 units per axilla.
- Single use, sterile 100 units vacuum-dried powder per vial for reconstitution only with sterile 0.9 NaCl prior to injection, then gently mix them by rotating the vial (clear, colorless & free of particles).
- 4 ml diluents added to 100 ml unit vial divided in 4 syringes resulting doses 2-5 units per 0.1 ml.
- Botox should be taken within 24 hrs after reconstitution.
- During this period, reconstituted Botox should be stored in a refrigerator.

How to inject Botox?

- 100 units of Botox (4 ml) is injected intradermally in 0.1 ml distributed in multiple sites (10-15) approximately 1-2 cm apart.
- The hyperhidrotic area to be injected should be defined using standard staining techniques:

(Minor's iodine-starch test):

- 1) Shave underarms & stop using deodorants for 24 hrs prior to the test.
 - 2) Patient should rest without exercise, hot drinks for 30 minutes prior to the test.
 - 3) Dry the underarm area & then immediately paint it with iodine solution.
 - 4) Allow it to dry then sprinkle starch powder.
 - 5) The hyperhidrotic area will develop a deep blue black color within 10 minutes.
- Each injection site has a ring of effect up to 2 cm in diameter.
 - If the injection sites are marked with ink, don't inject Botox through the ink mark to avoid permanent tattoo effect.

Botox should not taken if:

- Allergy to any of the ingredients.
- Allergic reaction to any other Botulinum toxin products.
- Skin infection at the planned injection sites.

Precaution & warnings:

- Potent units of Botox not interchangeable with other preparations of Botulinum toxin products.
- Spread of toxin effects.
- Concomitant neuromuscular disorder may exacerbate clinical effects of Botox.
- Safety of Botox with pregnancy, lactation & patients under 18 yrs is not detected yet.
- Patients should be evaluated for causes of secondary hyperhidrosis e.g. hyperthyroidism to avoid symptomatic treatment hyperhidrosis without the diagnosis or/and treatment of underlying disease.

Adverse effects:

- Pain & hemorrhage at the site of injection.
- Weakness of hand muscles & blepharoptosis in patients received Botox for palmer & facial hyperhidrosis.
- Hypersensitivity reaction "anaphylaxis, dyspnea, urticaria".
- Spread of toxin effect → "generalized muscle weakness, diplopia, blurred vision, drooping eyelid, hoarseness of voice, dysarthria, loss of bladder control.

Drug interaction:

- Concomitant treatment of Botox with:
 - Aminoglycosides.
 - Muscle relaxant.
 - Drugs interfering with neuromuscular transmission.
→ will potentiate its effect.
- Use of anticholinergic drugs with Botox may potentiate the systemic anticholinergic effect.
- As it is a therapeutic protein, there is a potential of formation of neutralizing antibodies to Botulinum toxin type A.
- Using the least effective dose at the longest intervals between injections will decrease this immunogenicity.